

breeding of *Culicoides guyanensis* and *C. furens*. Aerial applications of granular dieldrin (6.25 percent) at the rate of 13 pounds per acre possibly contributed to a brief reduction of the insects. Granular Abate (2 percent) at the rate of 6 pounds per acre was ineffective. Aerial ultra low volume applications of undiluted technical fenthion and malathion at the rate of 4 ounces per acre reduced the adults temporarily and on at least two occasions also reduced the larvae. Effective control was obtained by flooding the entire swamp with fresh water and ULV air spray of the marginal areas with fenthion or malathion.

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OPERATING THE JEFFERSON COUNTY (TEXAS) MOSQUITO CONTROL DISTRICT

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It is necessary to visualize the county, its surrounding areas, climate and unique problems to understand the operation of the Jefferson County (Texas) Mosquito Control District.

The Texas Land Office lists the area of the County as 1,387 square miles. There are over 200 square miles of salt marshes and about 150,000 acres of land involved in rice production.

Beaumont is a deep-sea port, about 40 miles by water, from the Gulf of Mexico. The highest land in Beaumont is 25 feet

above mean sea level. Flood stage of the Neches River at Beaumont is 5 feet above mean sea level.

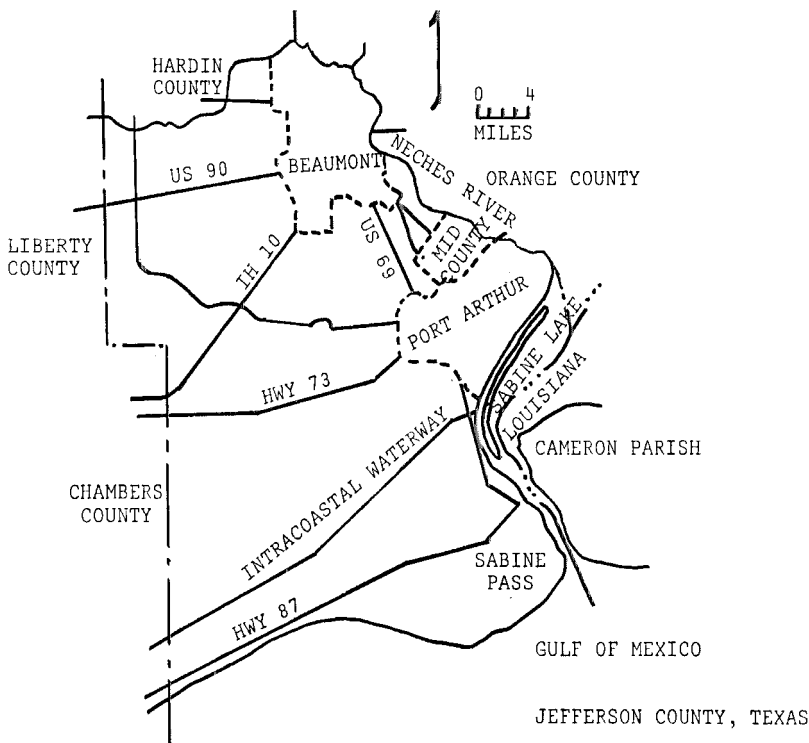
Port Arthur, a deep-sea port, about 12 miles inland is only slightly above sea level. Few, if any, of its drainage systems are above sea level.

The land along the Gulf of Mexico, from the beach to the Intracoastal Waterway, has a maximum natural elevation of 2 feet. Located in the northwest corner of the Gulf, the area is greatly affected by wind tides. Not to be confused with

high water caused by tropical disturbances, wind tides are caused by southeasterly winds blowing for several days. The level of the Gulf along the coast rises and water backs up into lowlands. River marshes at Beaumont sometimes flood as a result of wind tides. By way of contrast, our lunar tides rise and fall only 9 to 18 inches.

Orange County, east of Jefferson, is lower with more swamps. Chambers and Liberty Counties, to the west, are similar to Jefferson.

Louisiana is across Lake Sabine. Cameron Parish has over 100 square miles of salt marsh within easy mosquito flight range of Port Arthur. Part of the Sabine Migratory Waterfowl Refuge is in this



The county has an average annual rainfall of 53.09 inches; the maximum in one month is 24.25 inches. The average annual humidity at noon is 62 percent. The average daily maximum temperature is 78.3° F. and the minimum is 68.5° F. The mean wind speed is 10.3 miles per hour from the south. The average date of first killing frost is December 7 and the average for last killing frost is February 24.

area. Texas has some interesting laws. First in importance is the law providing the owner the right to deny entrance to anyone. This means not even an inspection without the owner's consent. It might be possible to get a court order; however, I do not know of such action. No State agency has any responsibility for the Mosquito Control Districts. The laws pertaining to mosquito control are

in the health laws but there is no further connection.

The State laws set a maximum limit on taxes that may be used for mosquito control.

The law prohibiting work outside the boundary of a District is a very serious handicap. No provision is made for control of serious breeding areas adjacent to a District.

The budget for 1969 was a total of \$223,000.00.

The District is organized as follows:

An Advisory Commission of five members, qualified property taxpaying voters of the County, are appointed by the Commissioners Court. Each Commissioner and the County Judge appoints one member. The members serve without compensation for a term of one year. The Advisory Commission meets monthly with the Director to review operations and set policies.

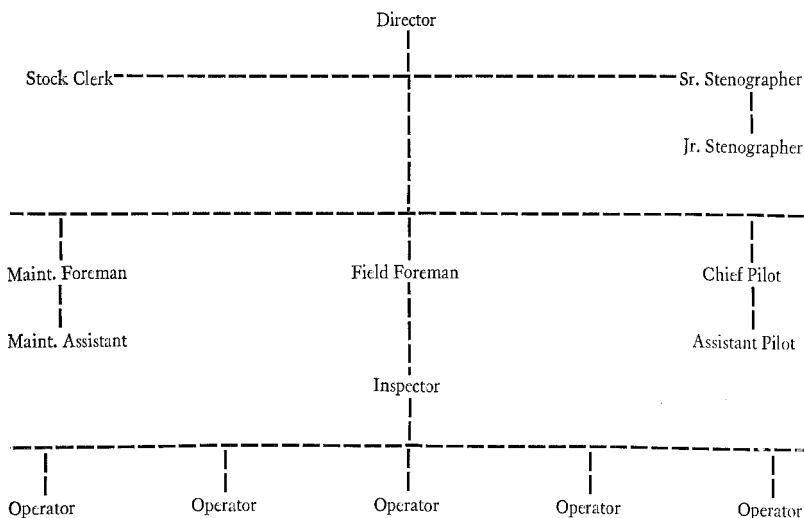
Personnel of the District are organized as shown in the accompanying chart.

hose, also a knapsack sprayer. The larvicide units are constructed in our shop.

Each operator is assigned a second vehicle equipped for low volume fog or U.L.V. mist for night adult control. The misters are of our own design and the foggers are modified in our shop. Adult control machines are equipped with a pressure tank for the insecticide solution. An air pump provides the air pressure to feed the insecticide into the mist or fog nozzle. The system eliminates maintenance problems caused by corrosive insecticides passing through a metal pump.

The Inspector is assigned a pick-up truck equipped with a U.L.V. Mister. He is thus prepared to do special adult control during the day if needed. He carries a supply of "Tossits" and can treat small or difficult areas.

Two vehicles, each specifically designed for a particular activity, have been found more efficient than one vehicle adaptable to more than one activity. U.L.V. adult control requires precise metering of the in-



Each operator is assigned a right-hand drive, 4-wheel-drive Scout equipped with a 100-gallon larvicide tank, pump and

secticide. Permanent installation of the units permits locating all controls and gauges in the truck cab. The operator is

able to monitor the operation of his unit and make corrections as needed.

The Field Foreman drives a station wagon stocked for minor repairs in the field.

The Maintenance Foreman is assigned a Travelal stocked for general repairs in the field. His assistant is assigned the spare adult control truck or spare larviciding truck. When expedient, the spare truck is substituted for a disabled unit. Thus repairs are made without loss of field time.

The Stock Clerk is assigned a pick-up truck with a Mister, providing transportation for purchasing during the day. The clerk drives on adult control operations at night.

The pilots are assigned a pick-up truck and a supply trailer.

The Director is assigned a passenger vehicle.

All vehicles, including the airplanes, are equipped with 2-way, F.M. radios.

The operation of the Jefferson County Mosquito Control District is directed almost entirely toward the control of adult mosquitoes. The control of the larval stages of *Aedes sollicitans* and *Psorophora confinnis* is economically impracticable or legally impossible. Larval control of *Culex quinquefasciatus*, a disease vector is conducted as a routine operation. Under normal conditions all known "quinq" breeding places can be treated within a 2-week period. The program is designed to eliminate the breeding of the species in populated areas.

The County is dominated by impervious silt clay soils of the Beaumont-Morey association. Septic tanks do not function. Each tank has at least one open-end line in its absorption field, usually leading to a road-side ditch.

Suburban areas not served by a central sewerage disposal system have the same problems and are included in the program. A similar program tries to control "quinqs" in the many breeding places furnished by an urban community. In-

secticides for larval control are used only in areas of considerable pollution. Currently the choice is Dursban.

Surface oiling is practiced where there is little or no pollution. Enco WK 80, a commercial weed killer, is used. The material is an excellent larvicide, being at least twice as toxic to larvae as diesel fuel oil #2. The material has the advantage of also controlling vegetation. Exposing an area to sun and wind greatly decreases the breeding potential.

The first field duty every Monday morning is a landing rate survey of the County. Landing rates are determined by counting the number of mosquitoes landing on the front of one's slacks between the ankle and belt. All field personnel, foreman, inspector and operators, fan out to 36 stations. Reports are made by radio. By 9:00 a.m. the office has a picture of mosquito populations throughout the County. The survey completed, field personnel go about their routine duty of controlling "quinqs." Landing rate surveys are conducted 2 or 3 times a week.

A "Produc-trol" panel in the office is used to tabulate field information. A "Produc-trol" panel is a type of peg board combined with a card file. Our board can handle 100 items over a range of 200 units. Each item has a file card indexed at the row. Pegs are of several colors to represent different activities. Pegs with a white cord, retracting behind the card file, form a bar graph depicting the progress of one activity. Such items as: landing rates, service requests, dates of prior treatment, time of next treatment, and comparison to previous years' operations are plotted.

Service requests, sometimes called "complaints," receive considerable attention. Every request is recorded on a special form. The name and address is required before a request will be considered. Other information includes the time and place of the incident. During the 15 hours a day that the office is not staffed, a "Code-a-phone" maintains contact with the pub-

lic. The "Code-a-phone," leased from Southwestern Bell Telephone Company, will answer a call, deliver a recorded message and then provide time for the caller to leave a message. The first office duty each morning is to record every service request from the Code-a-phone and plot the information on the Productrol.

By mid-morning a pattern evolves on the Productrol. The pattern develops as air and ground adult control assignments are added. The panel is up-dated throughout the day, every day, with new facts constantly reflecting changing field conditions.

The maintenance foreman is notified by noon when night work is planned. The eight spray units are checked, serviced and operated to insure proper functioning, then loaded with insecticide. Each motor vehicle is checked and serviced.

The maintenance shop is provided with a panel of switches, each with a pilot light. A light board is near the entrance to the District yard. Each operator has a numbered light on the board and panel. When an operator returns from a day of routine work, he is notified by the light that he is scheduled for night work. The District cannot afford two crews. Night adult control operations are by the regular workers. When, in an emergency, it is necessary to work more than two consecutive nights, the day work is reduced so that no operator works over 12 hours per day.

Ground adult control operations are conducted between 7:00 p.m. and midnight. Each truck is assigned a "Section" containing 1,800 to 2,000 acres. The vehicles are operated at a speed of 15 m.p.h. The District has four fog trucks and four mist trucks. One truck is a spare in case of a breakdown. All units operate at low volume rates, the insecticide formulation output is about 9 gallons per hour. The low volume fog technique is described in a paper by this author "Low Volume Fog and Mist for Ground Use" in *Mosquito News*, 29:2 (166-169) 6/69.

The rate of application by ground

equipment of insecticides is based on an assumed swath width of 500 feet. The actual width will vary depending on wind, vegetation, density of houses and poorly understood factors connected with heat and air in motion. The sections selected for treatment normally form a solid area. The "block" treating procedure has proved more satisfactory than treating isolated sections. It is most desirable that adjacent rural areas be sprayed by airplane to complete the "block" treatment when working suburban areas. The infiltration of uncontrolled adults into a treated area will nullify any good that is done.

The three major pest species of the area are able to fly considerable distances. *Aedes sollicitans* can make sustained flights of at least 21 miles. *Culex salinarius* is known to travel at least 12 miles in over-water flights. *Psorophora confinis* has been observed to migrate 9 miles a night through heavily wooded areas. Scattered small areas become reinfested rapidly.

Adult control by airplane is started about sunrise. Two Piper Pawnees are equipped for U.L.V. spraying. Each plane is capable of treating about 8,000 acres per flight. Our airport ranks fifth in Texas and traffic is a problem. Small auxiliary fields were considered a solution at one time. This involved two, 2,000-gallon tank trucks with drivers to service the planes for high volume spraying. U.L.V. spraying opened the way to greater economy and vastly improved control. The two planes are loaded by the pilots and are in the air over their assignments by sunrise. There is seldom more than one day a year when atmospheric conditions will permit more than one load of insecticide to be applied. It is more common that conditions do not permit application of one full load. The planes fly at 100 m.p.h. about 100 feet above the ground. Swath width is 500 feet.

Field observations and tests with caged mosquitoes have established rules governing adult control operations for the Dis-

trict. The rules apply generally to both ground and air application.

Temperatures below 70° F. indicate doubtful success. Temperatures below 60° indicate almost certain failure. The above temperatures are not necessarily those at the time of application. Good results may be obtained by spraying with temperatures in the 50's when the temperature will reach 70° within 2 to 3 hours. It is advantageous to increase the dose-rate of the insecticide at the lower temperatures. Through field experience we have learned that regardless of basic rules, if it feels warm, spray. You have a chance. If it feels cold, don't spray.

Winds in excess of 10 m.p.h. indicate doubtful success. Winds above 15 m.p.h. indicate almost certain failure. These limits are also modified. If an anemometer registers near 15 m.p.h., and the winds feel "soft" you have a chance. If the wind speed is near 10 m.p.h. and the wind feels "strong," don't spray.

Then there are thermals. These are most noticeable in air spraying. They are easily recognized by a pilot and indicate the end of effective, low volume spraying. During the hottest part of the summer thermals affect ground spraying but seldom reach a point of stopping an assignment.

Maps made by tracing from aerial photos are maintained for every air spray area in the District. The map scale is 8 inches equals 1 mile. Each map is traced on 10 x 10 cross-section paper, providing 6,400, 1/10 inch squares per 8-inch square. Each small square equals 1/10 acre. The maps facilitate close control of the area being treated and swath runs can be charted. All hazards to flight are plotted and constantly up-dated. Emergency landing spots are well marked.

A weather teletype stands in a corner of the office flanked by maps of Texas and the Continental U.S. The teletype is leased from the Southwestern Bell Telephone System. The ESSA Weather circuit deals specifically with the eastern half of Texas. National and, as needed inter-

national, weather conditions are reported. Routine radar coverage from Forth Worth, Brownsville and Galveston is on an hourly basis. Smaller radars supply additional information as needed. Weather information is never more than one hour old. Bulletins are more frequent when needed.

The excellent information available allows intelligent planning of all field activities. Prior to the use of the weather teletype we lost 56 adult control operations in one year. During 1969 only 8 operations were lost and the risk was deliberate due to the importance of the assignment.

All control work performed by the District is assigned and reported on maps. A large map of the County is divided into rectangles. Each rectangle is enlarged to fit an 8½ x 11 inch letter size page. These maps are used for larviciding assignments and reports. They require a minimum of descriptive writing.

Smaller scale maps are used for assigning and reporting ground and air adult control operations. They also provide excellent forms for recording of landing rates and similar data.

The cities of the County are divided into "Sections." A "Section" is an area that can be treated in one night, by one spray truck for the control of adult mosquitoes. Suburban and rural areas, better suited to airplane control operations, are divided into sections best suited to flying efficiency.

The District has perfected a simple method of calibrating a spray or fog U.L.V. Unit. Units are equipped with Brooks Flow Meters. A valve is installed in the insecticide supply line that will shut off the supply tank and open a nipple. A knapsack sprayer containing the spray solution being used, is attached to the nipple. The knapsack is pumped to a convenient pressure. Buckets are suspended under spray nozzles. In the case of a fog machine, the nozzle can be removed from the fog generator and placed in a bucket.

Similar procedures can be used for mist

blowers. If nothing else will work, fake a nozzle. A "Fake Nozzle" is an orifice having a flow rate equal to the desired rate. The sprayer is operated for one minute (or more), noting the position of the float in the flow meter. Once the correct flow rate is established, the float reading will be constant regardless of pressure.

Flow meters are sensitive to viscosity changes so that any change in formulation may necessitate recalibration. A similar method of calibrating an airplane spraying system has been developed.

Operations of the District are planned to give great consideration to the conservation of wildlife. Within the County we have the Murphree Wildlife Management Area. The 8,400 acre area is devoted to research concerning improvement of forage and shelter by water level control. In Louisiana, but only 6 miles from Port Arthur, is the western boundary of the Sabine Migratory Waterfowl Refuge.

It is another 35 miles to the eastern boundary of the Refuge. The salt marsh areas of the District are breeding grounds for many species of fish, crabs, shrimp, etc. The brackish marsh areas have their particular biota. Inland, the fresh water areas, including rice lands, add their production. Crawdads, sometimes called crayfish, are important. Crawdad farms have been established and catfish farms are being started.

Mosquito Control Districts must be operated by well trained personnel. The leadership must be very sensitive to other interests. Great care must be exercised in the choice of control measures. Mosquito control proponents and opponents alike must realize that each control area is a microcosm. It must be considered as an entity apart from all others. Methods, materials and practices acceptable in a neighboring microcosm may be completely unacceptable here.

SUSCEPTIBILITY OF *Aedes albopictus* (SKUSE) LARVAE FROM SOUTH VIETNAM TO FIVE INSECTICIDES, 1969¹

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INTRODUCTION. Most of the entomological activities in a war zone are necessarily of an applied nature. However, it is precisely in these areas of widespread and constant dispersal of insecticides that accurate and timely basic data are needed to evaluate the effectiveness of the applied programs. The insecticide susceptibility status of disease vectors in a war zone is

of particular importance to the medical entomologist.

This paper presents the results of a series of susceptibility-resistance studies in which indigenous *Aedes albopictus* larvae were tested against five insecticides commonly used in Vietnam. *A. albopictus* was chosen in this initial study because of its vector status and its abundance in Vietnam. This species has been implicated as a primary vector of dengue, Chikungunya fever, and *Dirofilaria immitis* (tropical eosiniphilia), and as a secondary vector of Japanese "B" encephalitis (Hunter, Frye and Swartzwelder, 1960 and Stojanovich, 1966).

¹The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

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